EFFECTS OF IMPACT VELOCITY AND STRESS CONCENTRATORS IN TITANIUM ON FAILURE BY ADIABATIC SHEARING

Third Interim Report
(March 25/99 - June 24/99)

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This Interim Report covers the contract period from March 25/1999 to June 24/1999 (the third period of three months). During this period the first series of the MDS (Modified Double Shear) specimens have been machined and the main part of experiments has been performed. The experiments were limited in this series to relatively low strain rates in shear, from 10^{E}-3 1/s to 5^{E}2 1/s. A fast hydraulic testing machine together with a special device to fix the MDS specimen was used. The oscillograms have been analyzed and variety of test data obtained for the Ti-6Al-4V alloy. It has been found that this alloy is very rate sensitive and the flow stress in this range of strain rates is proportional to the logarithm of strain rate.
New series of experiments was prepared to test this alloy in shear at high and very high strain rates, up to ~ 10^{E}5 1/s. The measuring system for the impact experiments on MDS specimens was put into operation.

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EXTENDED ABSTRACT

During the third period (three months from March 25/98 to June 24/99) of the Contract the experimental program was started. The first series of the MDS (Modified Double Shear) specimens of Ti-6Al-4V alloy have been machined and the firs series of experiments has been performed. The material (Ti-6Al-4V) was delivered by the ARL - Aberdeen, MD. The experiments were limited in this series of tests to relatively low strain rates in shear, from 10^E-3 1/s to 5^E2 1/s A fast hydraulic universal testing machine together with a special device to fix and load the MDS specimen were used. The device has its own gage system to measure force and displacement as a function of time, [1]. It was found that the this titanium alloy is very rate sensitive in this range of strain rates and the flow stress is proportional to the logarithm of strain rate. This is important because a variety of data must be collected, including effects of strain hardening, and also effects of strain rate and temperature, in order to properly construct the final constitutive relations. The literature data which were analyzed previously using many sources have been compared with the own data (double shear with MDS specimens). In this way the trends were found how the strain hardening curves for Ti-6Al-4V change as a function of strain rate and temperature. A wide range of strain rates, from quasi-static to about 10^E3 1/s, was covered in this analysis. The experimental results have been used to verify the constitutive relation developed at LPMM. This relation which takes into account the strain hardening, strain rate and temperature has been updated for Ti-6Al-4V alloy, and all material constants for this alloy have been found.

The LPMM has developed under previous contracts partially granted by the European Research Office of the US Army, a unique experimental technique which permits for shear testing of materials within wide range of strain rates, typically from 10^E-4 1/s to 10^E5 1/s, that is nine decimal orders in strain rate [1]. This technique is used to study titanium alloy Ti-6Al-4V up to strain rate 10^E5 1/s, including formation of ASB's (Adiabatic Shear Bands).

Since the experimental technique with the MDS specimens loaded by direct impact is quite complicated, the setup tuned up and the preliminary series of experiments was performed (strain rate in shear up to 10^E5 1/s. The oscillograms are under analysis. Those experiments, quasi-static and direct impact on MDS specimens will serve to verify the constitutive relation at very high strain rates as well as the CIV in shear (Critical Impact Velocity), [2].

Cont.

Refernces

[1] J.R.Klepaczko, An Experimental Technique for Shear Testing at High and Very High Strain Rates, the Case of Mild Steel, Int. J. Impact Engng., **15** (1994), 25.

[2] J.R.klepaczko and M.Klosak, Numerical Study of the Critical Impact Velocity in Shear, Eur. J. Mech. A/Solids, **18** (1999), 93.

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